Short and Sweet

PERCEPTION

Perception
2015, Vol. 44(7) 821–824

DOI: 10.1177/0301006615594699
pec.sagepub.com
SAGE

The Moon as a Tiny Bright Disc: Insights From Observations in the Planetarium

Claus-Christian Carbon
Department of General Psychology and Methodology, University of Bamberg, Bamberg, Germany; Graduate School of Affective and Cognitive Sciences (BaGrACS), Bamberg, Germany; Forschungsgruppe EPÆG (Ergonomie, Psychologische Æsthetik, Gestalt), Bamberg, Germany

Abstract
Despite a relatively constant visual angle, the size of the moon appears very variable, mostly depending on elevation and context factors—the so-called moon illusion. As our perceptual experience of the size of the moon is clearly limited to the perceptual sphere of the sky, however, we do not know whether the typical perception of the moon at its zenith reflects a veridical interpretation of its visual angle of only 0.5°. When testing the moon illusion in a large-scale planetarium, we observed two important things: (a) variation in perceptual size was no longer apparent, and (b) the moon looked very much smaller than in any viewing condition in the real sky—even when comparing it at its zenith. A closer inspection of the control console of the planetarium revealed that classic-analog as well as updated-digital planetariums use projections of the moon with strongly increased sizes to compensate for the loss of a natural view of the moon in the artificial dome of the sky.

Keywords
moon illusion, planetarium, perceived size, size constancy, darkness, elevation, real world, ecological testing, registered distance, apparent distance

> Perhaps future planetariums could be constructed in such a way as to include the audience's perceptions of form and structure in the nighttime sky. Not only might this alteration produce a version of the Moon Illusion indoors [. . .] (Wenning, 1995, p. 13)

Corresponding author:
Claus-Christian Carbon, Department of General Psychology and Methodology, University of Bamberg, D-96047 Bamberg, Germany.
Email: ccc@experimental-psychology.com

The moon travels around our home planet within a period of approximately 4 weeks, always showing us the same side due to its Earth-synchronized rotation. Over the duration of a complete orbit, the distance to the Earth is relatively constant, only varying by around 5.6% (with a semimajor axis of 384,399 km, an average Perigee of 362,600 km, and an average Apogee of 405,400 km) subtending a physical arc of about 0.52° (0.49°–0.55°). Despite this relative constancy of the physical angle of the moon, the *perceived* size of the moon varies dramatically—a phenomenon known as the *moon illusion*, already documented and described by ancient scientists and even visible in landscape paintings where the visual angle of the moon is artificially inflated (see Rock, 1995). Although a large volume of explanations and theories has been published on this intriguing effect so far (see Hershenson, 1989), one that is fully conclusive is not yet available (Ross & Plug, 2002).

The variety of theories propagated so far notwithstanding, we experience the variation of the size of the perceived moon very readily in the real sky, but we lack knowledge of the relationship the perceived *minimal moon* (when it is perceived as a very small moon, mostly at its zenith) has to the size of a projected bright disc spanning just about 1/360 of the entire visual field. When I entered the planetarium in Nuremberg for a public talk on perceptual effects some years ago, we spontaneously observed that the stars projected on the huge dome-shaped ceiling appear indeed very realistic in the fully dark conditions of the presentation, but that the moon seems to be unconvincingly small. Furthermore, and in accordance with pioneering planetarium work executed by Kaufman and Rock (1962b), our observations did not reveal any moon illusion. We used a sky dome of 9.0 m (Figure 1) and employed a presentation condition of total darkness where participants ($N = 5$ as in Kaufman & Rock, 1962b) were fully adapted to the darkness before being exposed to the spangled sky.

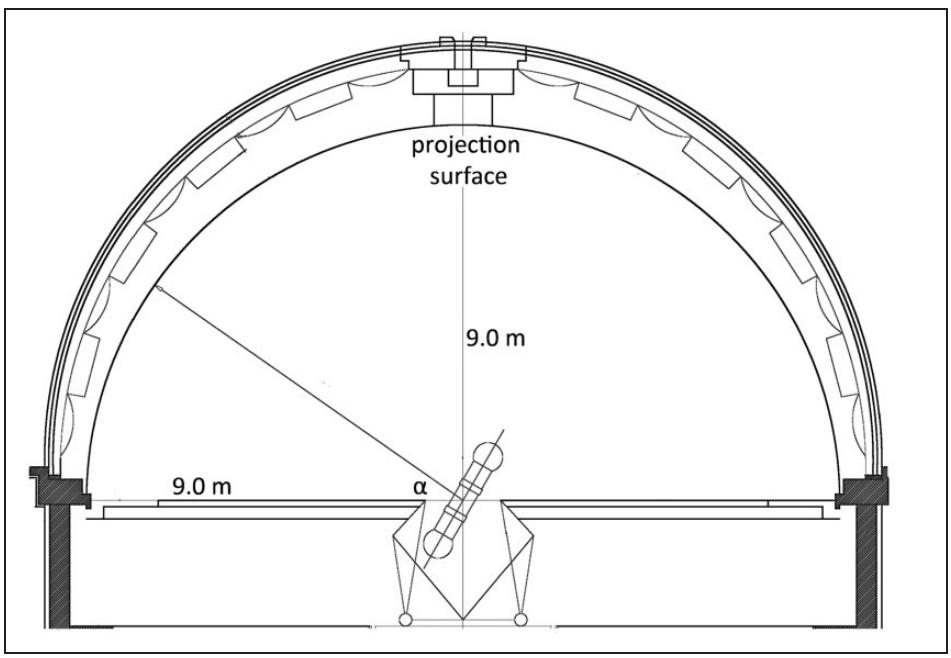

Figure 1. Experimental setting in the planetarium. In the center, devices are installed which project the sky images onto the hemispheric projection surface.

We did not follow the experimental procedure of Suzuki (1991) who projected artificial red beams (HeNe lasers with an emitted wavelength of 632.8 nm, projected on a dome of a planetarium with equidistance of 9.2 m from the center to the any point of the screen) for simulating the moon, as this specific procedure with red laser light potentially makes it impossible to accommodate on the spots of light with the results of uncertain distances from the observers. Instead, we used the digital capabilities of the high-resolution full dome presentation system (DigitalSky 2 by Sky-Skan, Inc.) to show a moon with a very realistic outward appearance most similar to Kaufman and Rock (1962b, 1989). However, as we were interested in a preferably ecological setting, we decided against a comparison task with two moons available simultaneously but instead used a task in which the participant simply had to assess the size of a unique moon.

We varied the elevation angle α of the projected moon between approximately 3° (*horizon*), 45° (*medium*), and 90° (*zenith*); the task was (a) to rate the size of the moon on a scale of 1 (*super small*) to 7 (*very large*) and (b) to qualify whether the moon was displayed in a familiar size, typically perceived in real-world settings. For all elevation conditions, the given ratings were 1 (*zero variance*)—furthermore, all participants experienced the moon as *massively too small*. Note: This experience was also affectively accompanied by a clear disappointment at the moon substantially differing from natural conditions in terms of its size—this notion was supported by the director of the planetarium who told us that the audience is often disappointed by the outward appearance of the moon. This had already been mentioned in quite a similar way by the director of the Hayden Planetarium, who specifically reported

Figure 2. Screen shot of the planetarium's control console: The moon size for a typical planetarium show is increased by 250% (*show size*) for the digital and by 150% (*Zeiss size*) for the analog presentation device.

during the testing of Kaufman and Rock (1962a) that his audiences found the moon in the planetarium to be artificially small. Clearly, our measurement method was not specifically sensitive in uncovering subtle changes in size between the conditions, but instead indicated the main point here is that the projected moon always appeared unrealistically small! Even more sensational was the finding that first by merely applying the rule of thumb of estimating the visual angle of the projected moon and second by verifying the planetarium's control console; the moon, although appearing much smaller than in the real sky, was displayed in a physically much larger way—actually enlarged by 250% (see Figure 2).

In a nutshell, the perception of the moon in the artificial dome is *always* greatly reduced in size—even when compared with the everyday life experience of a super small moon in the real world. This might point to a very important differentiation between processing distances: Although on one hand we are not aware of any spatial limitations when looking at the planetarium's spangled sky, the *registered distance* (i.e., an automatic, nonconscious process for computing distance Kaufman & Rock, 1989) to the moon seems to take such a limitation into account, yielding the perception of a tiny bright disc. To compensate for this massive loss of perceived size, engineers have added the feature of a *show size moon* which, despite all efforts, does not help to regain the perception we are so fascinated about: a substantially large, fine-graded, and characteristically shining moon.

Acknowledgements

I would like to express my gratitude to Klaus Herzig of the Nicolaus-Copernicus-Planetarium in Nuremberg/Germany who provided all the technical information on the planetarium and who supported the testing in the planetarium. I am also indebted to Rob van Lier and two anonymous reviewers who gave important advice for a previous version of this manuscript and draw my attention to important details from the first moon illusion research conducted in a planetarium by Kaufman and Rock (1962a).

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

Hershenson, M. (Ed.). (1989). *The moon illusion*. Hillsdale, NJ: Erlbaum.

Kaufman, L., & Rock, I. (1962a). Moon illusion. *Scientific American*, *207*, 120–131.

Kaufman, L., & Rock, I. (1962b). Moon illusion, 1. Explanation of this phenomenon was sought through use of artificial moons seen on sky. *Science*, *136*, 953–961.

Kaufman, L., & Rock, I. (1989). The moon illusion thirty years later. In M. Hershenson (Ed.), *The Moon Illusion* (pp. 193–234). Hillsdale, NJ: Erlbaum.

Rock, I. (1995). *Perception*. New York, NY: Scientific American Library.

Ross, H. E., & Plug, C. (2002). *The mystery of the moon illusion*. New York, NY: Oxford University Press.

Suzuki, K. (1991). Moon illusion simulated in complete darkness: Planetarium experiment reexamined. *Perception & Psychophysics*, *49*, 349–354.

Wenning, C. J. (1995). New thoughts on understanding the moon illusion. *Planetarian*, *14*, 10–13.